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TO ALL WHOM IT MAY CONCERN:

Be it known that I, Rolf Hartung, , a citizen of Germany, have invented an improvement in:

HANDLING SYSTEM

of which the following is a

SUBSTITUTE SPECIFICATION

SPECIFICATION

BACKGROUND OF INVENTION

[0001] The invention relates to a handling system for receiving and handling a product, which has been transferred from a cassette by a handler, and for providing the product to a processing station.

[0002] The invention is particularly useful for handling wafers, such as semiconductor wafers, that are to be subjected to heat treatment in a processing station, such as a vacuum chamber, to perform processes such as a vacuum soldering or wafer bumping in a wafer bumping device which includes a vacuum chamber. To this end, it is necessary to remove the wafers from a transport container and to transport them into the vacuum chamber by means of a suitable handling device. However, this means that the vacuum chamber must be opened, i.e. standard pressure must first be established in the vacuum chamber, which involves a simultaneous loss of heat and change in the atmosphere in the vacuum chamber. Consequently after loading with one or more wafers, the vacuum chamber must be flushed and the desired gas composition must be

established, for example by the introduction of an inert gas or a process gas, and at the same time, the requisite vacuum for the particular processing step must be reestablished. In addition, the wafers must be heated to the necessary process temperature.

[0003] After completion of the processing step in the vacuum chamber, it is necessary to cool the wafers evenly to a temperature in the vicinity of room temperature prior to their removal in order to avoid thermal shock upon removal from the vacuum chamber resulting from a possible extreme cooling rate (high temperature gradient).

[0004] Consequently, it is desirable that handling of the wafers, in particular transport of the wafers into the processing station and removal of the wafers from the processing station, can be accomplished as simply and rapidly as possible by a suitable handling system.

[0005] The object of the invention is thus to create a handling system that permits secure and rapid handling of the product and that has, in particular, a long service life and is subjected to low mechanical and thermal stress.

SUMMARY OF THE INVENTION

[0006] This object of the invention is achieved in a handling system of the aforementioned type in that there is provided in the processing station an internal handling system having at least one fork that can be moved with several degrees of freedom and that interacts with grippers of an external handling system so that the product (wafers) transported into the vacuum chamber by the external handling system can be received by the fork and placed by the same on a holding device.

[0007] In this way, a simple division into an internal and an external handling system is achieved so that the processing step can be completely isolated within the processing station, and the processing chamber need only be opened briefly for removal and reloading.

[0008] In a further development of the invention, the fork of the internal handling system can be moved under the placement location of the wafer on the holding device. Simple handling of the wafer is thus achieved in that it is merely lifted from underneath by the fork without additional mechanical aids and transported to the next placement location.

[0009] A further embodiment of the invention is characterized in that the holding device in the processing chamber has at least one cooling plate and at least one heating plate. In this way, the wafer can be heated inside the processing chamber (vacuum chamber) to the processing temperature required for the relevant processing step, and can be cooled to a temperature suitable for removal from the processing chamber after completion of the processing step by transfer to the cooling plate. The open time of the processing chamber can thus be further reduced.

[0010] The cooling plate and the heating plate can be arranged next to one another or one behind the other.

[0011] Another special embodiment of the invention is characterized in that the internal handling system consists of a transverse guide upon which the fork is supported in a mount, such that it can move vertically and laterally, and is located behind the plates.

[0012] Preferably the internal handling device is accommodated in a cooled area of the processing chamber and/or is associated with a cooling device for temperature control.

[0013] In another special refinement of the invention, instead of the use of two adjacent plates in the holding device, a multiple arrangement is provided in that multiple cooling and heating plates are arranged in a stack. For example, the multiple arrangement can consist of 12 or 24 layers in a stack that can be loaded sequentially or simultaneously.

[0014] In an advantageous variant of the invention, the fork of the internal handling system can be preheated so that the wafer to be removed from the heating plate can be removed without first having to be cooled.

[0015] Heating of the fork can advantageously be achieved by bringing it into contact with the heating plate for a long enough time before removal of a wafer that a predetermined temperature is reached.

[0016] In a further advantageous development of the invention, an additional handling system is installed opposite the handling system.

[0017] In addition, multiple processing chambers can be stacked on top of one another and/or next to one another.

[0018] In order to facilitate a continuous process flow, an additional option for removal of the wafers can be provided through a rear wall of the chamber, by providing the rear wall of the processing chamber with a closable opening that is associated with a second handling system (handler) or another transport system.

[0019] In order to prevent the entry of dust into the processing chamber, a covering may be provided surrounding the chamber and the transfer area of the transport magazine for wafers to

achieve a dust-free area. This area within the covering can advantageously be purged with hydrogen/nitrogen gas at low overpressure.

[0020] The invention is explained in detail below using an example embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Fig. 1 is a simplified representation of a processing chamber in accordance with an embodiment of the invention with an internal handling system; and

[0022] Fig. 2 is a simplified perspective view of the structure of the internal handling system of Figure 1.

DESCRIPTION OF THE INVENTION

[0023] The product to be handled, for example in the present case a 300 mm wafer, is placed on a conventional loading station 1 in a special cassette. An external handling device 2, which is located under a cover 3, removes the waver 4 from the special cassette through the port 5 using grippers and, while processing chamber 6 is open, transports it onto a cooling plate 7 located therein that is part of a holding device which includes the cooling plate 7 and a heating plate 8. From this cooling plate 7, grippers (not shown) of the holding device accept the wafer 4 and hold it at a predetermined height until the external handling device 2 is retracted and the processing chamber 6 is closed.

[0024] The processing step now begins in the processing chamber 6 (e.g. a vacuum chamber or vacuum oven), in that an internal handling device 9 accepts the wafer 4 from the gripper of the holding device by means of a fork 10. The wafer 4 is transported over the heating plate 8 by the

fork 10 and is lowered onto another holding device associated with this heating plate 8. In this process, the fork 10 is lowered slightly and moved back to an advantageous waiting position.

[0025] The cooling plate 7 and the heating plate 8 are arranged next to one another in the processing chamber 6, as is shown schematically in Fig. 2. Located behind the plates 7, 8 is the internal handling system 9 with a transverse guide 11 upon which the fork 10 is supported in a mount 12 such that it can move vertically and laterally.

[0026] At the end of the thermal treatment performed over the heating plate 7, the wafer 4 is lifted with the holding device. The fork 10 now moves back under the wafer 4 and accepts it. The internal handling device 9 transports the wafer 4 over the cooling plate 7 and lowers it until it contacts the cooling plate 7. Once a predetermined temperature is reached, the processing chamber 6 is opened. The gripper 13 (shown schematically) of the external handling device 2 removes the wafer 4 and transports it back into the transport cassette.

[0027] The process can then be repeated with a new wafer 4.

[0028] It is important for the function of the internal handling device 9 that it is accommodated in a cooled area of the processing chamber 6. A cooling device for temperature control can be associated with the internal handling device 9.

[0029] Instead of using two adjacent plates 7, 8, it is also possible to provide a multiple arrangement in that multiple cooling and heating plates 7, 8 are arranged one above the other in several layers. In this way it is possible to provide 12 or 24 layers one above the other.

[0030] It is possible to load the layers sequentially or simultaneously, which leads to a significant reduction in the cycle time.

[0031] In a variant, the plates 7, 8, rather than being next to one another (Fig. 2), can be one behind the other, so that the cooling plates 7 are located in front of the heating plates 8. This would have the advantage of a staggering of temperature as seen over the depth of the processing chamber 6. In other words, the cooler region is in front, hence in the transfer area from the external handling device 2 to the internal handling device 5.

[0032] In order to prevent thermal shock when transferring a heated wafer following heat treatment in the processing chamber 6, the fork 10 is preheated. Preheating can be accomplished in that the fork 10 is placed in contact with the heating plate 8 long enough to reach a desired temperature before transferring a wafer.

[0033] Furthermore, it is possible to install an additional handling device opposite the internal handling device 9, or to stack multiple processing chambers 6 on top of and/or next to one another.

[0034] In a special variant of the invention, an additional option for removal of the product (wafers 4) is provided through the rear wall 14 of the processing chamber 6. Removal can be accomplished with a second external handling device (handler) or another transport system. In this way a continuous flow method is implemented in that the wafers are transferred from the first external handling device 1 into the processing chamber 2 and, after the specified processing, are removed by the second external handling device. Commercially available devices can be used for the external handling devices (handlers).

[0035] Inside the processing chamber 6, the wafers 4 are automatically transported from a heat source (heating plate 8) to a cooling plate 7. The wafer transport system is comprised of three sections.

[0036] The first section relates to transport within the processing chamber 6. It encompasses the acceptance of the wafers 4 at the chamber entrance, the processing of the wafers 4 within the processing chamber 6, and the return transport of the wafers 4 to the chamber entrance.

[0037] The second section is located in front of the processing chamber 6 and is arranged between the entrance of the processing chamber 6 and the output of the semi standard load port for 300 mm wafers.

[0038] The external handling device 2 (handling system) takes the wafers 4 from this port 5 and transports them into the processing chamber 6.

[0039] At the end of, for example, the wafer bump reflow soldering process in the processing chamber 6, the external handling device 2 takes the wafers 4 and transports them back through the standard load port into the cassette box.

[0040] The third section is located in front of the standard load port; here, the transport cassette (FOUP = Front Opening Unified Pod) and the wafers 4 contained therein can be removed manually or by means of a robot.

[0041] The entire area in which the wafers 4 are moved is protected from environmental influences, so that no particles can penetrate into this area. This area can be flushed with hydrogen/nitrogen at low overpressure.

[0042] While there has been described what are believed to be the preferred embodiment of the invention, those skilled in the art will recognize that other and further modifications may be made thereto without departing from the spirit of the invention, and it is intended to claim all such changes and modifications as fall within the true scope of the invention.

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Handling System

The invention relates to a handling system for removing wafers provided from a cassette and for transferring the same to a vacuum chamber for heat treatment of the wafers, with an external and an internal handling device, wherein the internal handling device has at least one fork that can be moved with several degrees of freedom and that interacts with grippers of the external handling device. The above-mentioned wafers can be understood to include semiconductor wafers which are to be subjected to heat treatment inside a processing station, for example a vacuum chamber, for example in order to perform a vacuum soldering process or wafer bumping process in a wafer bumping device (wafer bumping equipment) that encompasses the vacuum chamber. To this end, it is necessary to remove the wafers from a transport container (FOUP = Front Open Unified Pot) and to transport them into the vacuum chamber by means of a suitable handling device. However, this means that the vacuum chamber must be opened, i.e. standard pressure must first be established in the vacuum chamber, which involves a simultaneous loss of heat and change in the atmosphere in the vacuum chamber. Consequently after loading with one or more wafers, the vacuum chamber must be flushed and the desired gas composition must be established, for example by introduction of an inert gas or a process gas, and at the same time, the requisite vacuum for the particular processing step must be reestablished. In addition, the wafers must be heated to the necessary process temperature.

After completion of the processing step in the vacuum chamber, it is necessary to cool the wafers evenly to a temperature in the vicinity of room temperature prior to their

removal in order to avoid thermal shock upon removal from the vacuum chamber resulting from a possible extreme cooling rate (high temperature gradient).

Consequently, it is desirable that handling of the wafers, in particular transport of the wafers into the vacuum chamber and removal of the wafers from the vacuum chamber, can be accomplished as simply and rapidly as possible by a suitable handling system.

Thus, a device and a method for treatment of substrates emerge from US-A-5-919-529 which encompass a plurality of transport devices. These transport devices are arranged such that their working areas partially overlap, so that the substrates can be transported through a number of processing stations one after another.

Moreover, US-A-4-816-116 describes a wafer transfer system with which wafers can be transported into a vacuum chamber from outside. To this end there is located within the chamber a rotating transfer arm whose wafer receptacle can be moved outside the chamber. This transfer system is extremely complex mechanically and contains several wear-prone linkages.

Lastly, US-A-5-972-110 describes a transfer system with which wafers can be transported in handling units, wherein there is also described a variant in which the wafers can be transported into the treatment chamber from one side and removed on the opposite side.

The object of the invention is thus to create a handling system that permits secure and rapid handling of the product while avoiding the disadvantages of the prior

art and that has, in particular, a long service life and is subjected to low mechanical and thermal stress.

This object of the invention is achieved in a handling system of the aforementioned type in that the wafers that are transported into the vacuum chamber by the external handling device can be placed on a cooling plate of a holding device consisting of the cooling plate and a heating plate, wherein the fork (10) of the internal handling device (9) can be moved between the heating plate (8) and the cooling plate (7) and interacts with the holding device for the wafers, and in that the internal handling device is accommodated in a cooled area of the vacuum chamber.

In this way, a simple division into an internal and an external handling system is achieved so that the processing step can be completely isolated within the vacuum chamber, and the vacuum chamber need only be opened briefly for removal and reloading.

Moreover, in this way the wafer can be heated inside the vacuum chamber to the processing temperature required for the relevant processing step, and can be cooled to a temperature suitable for removal from the vacuum chamber after completion of the processing step by transfer to the cooling plate. The open time of the vacuum chamber can thus be further shortened.

In a further development of the invention, the fork of the internal handling system can be moved under the placement location of the wafer on the holding device. Simple handling of the wafer is thus achieved in that it is merely lifted from underneath by the fork without additional mechanical aids and transported to the next placement location.

The cooling plate and the heating plate can be arranged next to one another or one behind the other.

Preferably a cooling device for temperature control is associated with the internal handling device.

In another special refinement of the invention, the multiple arrangement can consist of 12 or 24 layers in a stack that can be loaded sequentially or simultaneously (e.g. at one time).

In an advantageous variant of the invention, the fork of the internal handling system can be preheated so that the wafer to be removed from the heating plate can be removed without first having to be cooled.

Heating of the fork can advantageously be achieved in that it is in contact with the heating plate for a long enough time before removal of a wafer that a predetermined temperature is reached.

In a further advantageous development of the invention, an additional handling device is installed opposite the internal handling device.

In addition, multiple vacuum chambers can be stacked on top of one another and/or next to one another.

In order to facilitate a continuous process flow, an additional option for removal of the wafers can be provided through a rear wall of the chamber in that the rear wall of the vacuum chamber is equipped with a closable opening that is associated with a second handling system or another transport system.

In order to prevent the entry of dust into the vacuum chamber, a covering surrounds it and the transfer area of the cassette to achieve a dust-free area . This area

within the covering can advantageously be purged with hydrogen/nitrogen at low overpressure.

The invention is explained in detail below using an example embodiment. The associated figures of the drawings show:

Fig. 1: a schematic representation of a vacuum chamber in accordance with the invention with an internal handling system; and

Fig. 2: the schematic structure of the internal handling system.

The product to be handled, for example in the present case a 300 mm wafer, is placed on a conventional loading station 1 in a special cassette (FOUP). An external handling device 2, which is located under a cover 3, removes the waver 4 from the special cassette through the port 5 and, while vacuum chamber 6 is open, transports it onto a cooling plate 7 located therein that is part of a holding device consisting of the cooling plate 7 and a heating plate 8. From this cooling plate 7, grippers (not shown) of the holding device accept the wafer 4 and hold it at a predetermined height until the external handling device 2 is retracted and the vacuum chamber 6 is closed.

The processing step now begins in the vacuum chamber 6, or vacuum oven, in that an internal handling device 9 accepts the wafer 4 from the gripper of the holding device by means of a fork 10. The wafer 4 is transported over the heating plate 8 by the fork 10 and is lowered onto an additional holding device associated with this heating plate 8. In this process, the fork 10 is lowered slightly and moved back to an advantageous waiting position.

The cooling plate 7 and the heating plate 8 are arranged next to one another in the vacuum chamber 6, as is shown schematically in Fig. 2. Located behind the plates 7, 8 is the internal handling system 9 with a transverse guide 11 upon which the fork 10 is supported in a mount 12 such that it can move vertically and laterally.

At the end of the thermal treatment performed over the heating plate 7, the wafer 4 is lifted with the holding device. The fork 10 now moves back under the wafer 4 and accepts it. The internal handling device 9 transports the wafer 4 over the cooling plate 7 and lowers it until it contacts the cooling plate 7. Once a predetermined temperature is reached, the vacuum chamber 6 is opened. The gripper 13 (shown schematically) of the external handling device 2 removes the wafer 4 and transports it back into the transport cassette (FOUP).

The process can then be repeated with a new wafer 4.

It is important for the function of the internal handling device 9 that it is accommodated in a cooled area of the vacuum chamber 6. A cooling device for temperature control can be associated with the internal handling device 9.

Instead of using two adjacent plates 7, 8, it is also possible to provide a multiple arrangement in that multiple cooling and heating plates 7, 8 are arranged one above the other in several layers. In this way it is possible to provide 12 or 24 layers one above the other.

It is possible to load the layers sequentially or simultaneously (e.g. at one time), which leads to a significant reduction in the cycle time.

In a variant, the plates 7, 8, rather than being next to one another (Fig. 2), can be one behind the other, so that the cooling plates 7 are located in front of the heating

plates 8. This would have the advantage of a staggering of temperature as seen over the depth of the vacuum chamber 6. In other words, the cooler region is in front, hence in the transfer area from the external handling device 2 to the internal handling device 5.

In order to prevent thermal shock when transferring a heated wafer following heat treatment in the vacuum chamber 6, the fork 10 is preheated. Preheating can be accomplished in that the fork 10 is placed in contact with the heating plate 8 long enough to reach a desired temperature before transferring a wafer.

Furthermore, it is possible to install an additional handling device opposite the internal handling device 9, or to stack multiple vacuum chambers 6 on top of and/or next to one another.

In a special variant of the invention, an additional option for removal of the product (wafers 4) is provided through the rear wall 14 of the vacuum chamber 6. Removal can be accomplished with a second external handling device or another transport system. In this way a continuous flow method is implemented in that the wafers are transferred from the first external handling device 1 into the vacuum chamber 2 and, after the specified processing, are removed by the second external handling device. Commercially available devices can be used for the external handling devices.

Inside the vacuum chamber 6, the wafers 4 are automatically transported from a heat source (heating plate 8) to a cooling plate 7. The wafer transport system is comprised of three sections.

The first section relates to transport within the vacuum chamber 6. It encompasses the acceptance of the wafers 4 at the chamber entrance, the processing

of the wafers 4 within the processing chamber 6, and the return transport of the wafers 4 to the chamber entrance.

The second section is located in front of the vacuum chamber 6 and is arranged between the entrance of the vacuum chamber 6 and the output of the semi standard load port for 300 mm wafers.

The external handling device 2 (handling system) takes the wafers 4 from this port 5 and transports them into the vacuum chamber 6.

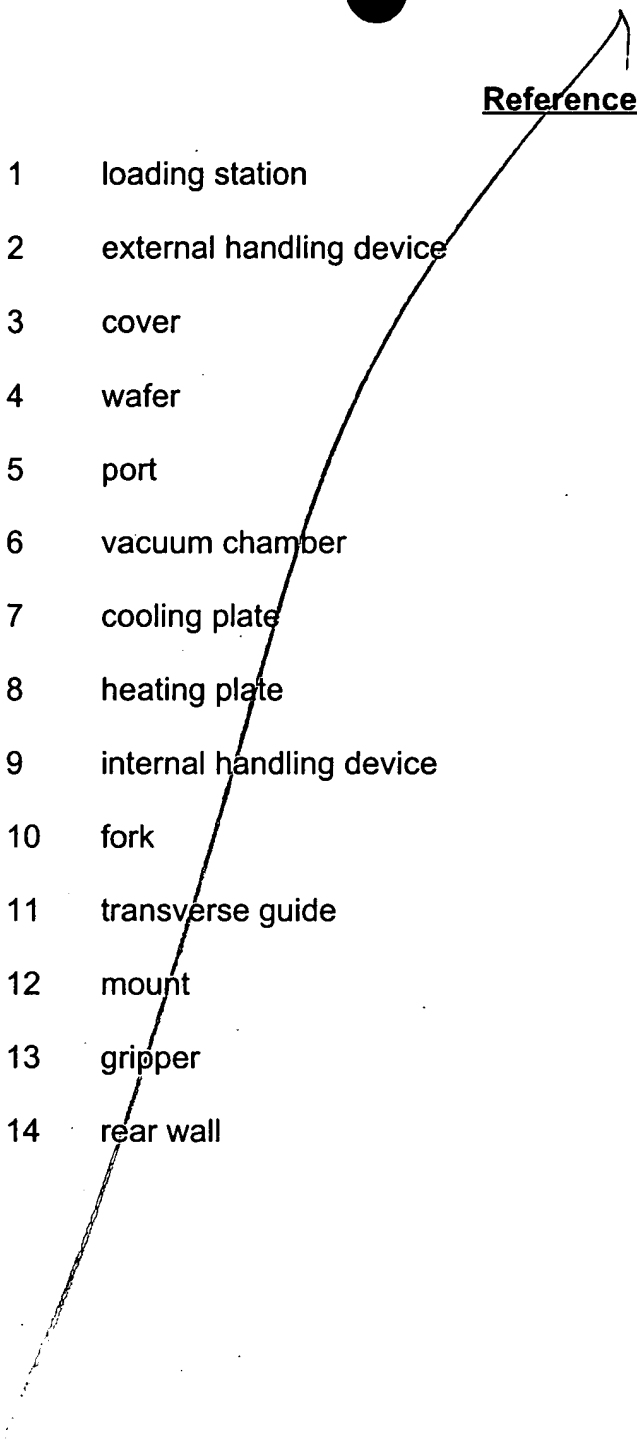
At the end of, for example, the wafer bump reflow soldering process in the vacuum chamber 6, the external handling device 2 takes the wafers 4 and transports them back through the standard load port into the FOUP box.

The third section is located in front of the standard load port; here, the transport cassette (FOUP = Front Opening Unified Pod) and the wafers 4 contained therein can be removed manually or by means of a robot.

The entire area in which the wafers 4 are moved is protected from environmental influences, so that no particles can penetrate into this area. This area can be flushed with hydrogen/nitrogen at low overpressure.

Reference Symbols

1	loading station
2	external handling device
3	cover
4	wafer
5	port
6	processing chamber
7	cooling plate
8	heating plate
9	internal handling device
10	fork
11	transverse guide
12	mount
13	gripper
14	rear wall



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